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FISHERY STOCK ASSESSMENTS AND PERFORMANCE MEASUREMENT IN THE CONTEXT OF THE NMFS STRATEGIC PLAN

By

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National Marine Fisheries Service

Fishery Stock Assessments and Performance Measurement in the Context of the NMFS Strategic Plan

I. Introduction

This report outlines the thinking to date of a contingent of stock assessment experts[1] and managers[2] who addressed the question of how to measure performance under the existing NOAA Fisheries Strategic Plan's Objective 1: Maintain healthy stocks important to commercial, recreational, and subsistence fisheries, with its accompanied Measure of Performance 1.2: Reduce the level of uncertainty associated with our estimates of stock status and biological potential below 1996 levels.

The group thought it was important for the National Marine Fisheries Service (NMFS) to engage the kinds of people doing the work in the discussion of how best to measure their stock assessment outputs, their contribution to fisheries management, and ultimately the outcome of the fishery management process. It is likely that a series of such discussions will be necessary to develop a deeper understanding of how performances should be measured for various aspects of the agency's program and strategic plan.

The problem, findings, and key ideas are summarized in this report; the appendix contains the notes and summaries sent by individuals and groups as expansions or records of the ideas expressed in the videoconference.

II. The Problem

At the behest of the NMFS Headquarters Planning Division, the Southwest Fisheries Science Center was asked *to examine the ways and means it might go about defining the elements to be measured and, thereafter, the means of measuring its stock assessment performance under the strategic plan and stated measure of performance.*

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[1] Chris Boggs, Gerard DiNardo, Anne Hollowed, David Holts, Jim Ianelli, Larry Jacobson, Pierre Kleiber, Alec MacCall, Rick Methot, Joe Terry, Grant Thompson, Jerry Wetherall

[2] Jim Cohen, Svein Fougner, Norris Jeffrey, Herb Kaufman, and David Mackett

As a first step the Center compiled and examined its recent fishery stock assessments and their respective measures of precision. However, in analyzing the relationship of precision to the overall performance of the management system, it quickly became apparent that, in most cases, simply and solely improving the level of precision (reducing the level of uncertainty by reducing the coefficient of variation or CV, for example) of the Southwest stock assessments did not seem like the logical thing to do to improve or ensure the ultimate performance - that of maintaining stocks of fish at healthy levels.

This disconnect seems to lay in the fact that fisheries management is a complex system of interacting parts and that simply improving the precision of one component of the system will not necessarily guarantee that the system will improve or even maintain its performance. Yet, on the other hand, intuitively and scientifically it makes sense to measure the performance of such an important component of fisheries management and to make what improvements may be called for in the overall context of improving the fishery management system.

At this point the aid of the panel of experts was enlisted and subsequently a two-hour video conference was held on December 18, 1997, to discuss the problem. NMFS Headquarters, Alaska Fisheries Science Center, Northwest Fisheries Science Center, Southwest Region Santa Rosa Office (for Tiburon Laboratory), Southwest Region Long Beach Office, the Southwest Fisheries Science Center, and Honolulu Laboratory sites were connected.

III. The Findings

Several general issues arose which called into question the manner in which NMFS wishes to conduct performance measures. A central question is, who is responsible for measuring performance and to what purpose will the information be put? Most envisioned that Congress, NOAA, or the NMFS hierarchy would want such performance measures for planning, programming, or budgeting purposes - to make changes in the status quo when conditions called for it. It was recommended that such policies and procedures ultimately be spelled out explicitly. The group members made most of their comments under the assumption that the NMFS management would be the primary users of the information.

Most agreed that the Performance Measure 1.2 as it stood was **misplaced**, in that the measure of whether or not fish stocks were being maintained at healthy levels had less to do with improving the precision of stock assessments than the integrity of the overall fishery management process and the interrelationships among all the systems

components. As an extreme example to illustrate the point, a perfectly precise (and accurate) stock assessment could be provided to fishery managers who then go on to misjudge its consequences, to apply faulty economic data, to succumb to political pressures, to ignore scientific processes, and to disdain caution altogether - the result or outcome in this case could hardly be the reflection of the stock assessment work.

It was generally believed that most stock assessment/fishery management situations fit these conditions and that only rarely was the precision of the stock assessment a factor in the quality of fishery management. Therefore, it is thought that an analysis or an assessment of an entire fishery management system (at all levels) is a requisite for measuring performance and ultimately improving it.

Most also thought that Performance Measure 1.2 is **too restrictive** to be used in the general context of measuring and improving fishery stock assessments in NMFS, regionally, or for specific fisheries or groups of fisheries.

Given the foregoing, the performance measure may need to be rewritten and relocated in the strategic plan to guide the measurement and ultimate improvement of stock assessments in the agency or at the regional or local level. Just what should be observed and measured at each level is open for interpretation and the question brings to mind the need for an overall definition of terms and a common understanding of purpose.

There are some terms that need to be defined in the context of measuring performance. For example, the *output* of any system such as fishery management can be described and compared to some standard (a watch's output - the time - can be compared to the U.S. Navy's standard time) and the *difference between the output and the standard* can be observed or measured (the watch's system loses 3 seconds a month). However, the *outcome* of such a system is relative and must be *diagnosed* in context.

Consider the following two situations using the same watch (system): 1) "As a consequence of the watch's horrible performance the space-shuttle to Pluto missed by 14 million miles and is now irretrievably on its way to Andromeda", or 2) "As a consequence of the watch's phenomenal performance, Green Bay's quarterback could control the clock and take no time-outs during the "2-minute drills" which resulted in an extra 12 touchdowns during the season and a Super Bowl win". Same watch, same system, same data, same performance, different contexts, and vastly different quality of outcomes.

Therefore, as just demonstrated, the measurement of performance is only part of the problem; evaluation and diagnosis, using specified criteria, within the proper context must also take place. One could establish a four-step process – description, diagnosis, prescription, and implementation – to measure and evaluate performance and then, if the system needs improvement, to make the necessary adjustments.

III.A. Stock Assessment Performance Measures Within Two Important Contexts

As mentioned previously, the utility of the performance measurement and its application for diagnosis is contextually dependent; not surprisingly then do we find a dichotomy in the suggestions for improving the performance measures. Those whose focus was on the overall state of stock assessments in the agency were comfortable with offering check-lists and principles to measure (improving) performance over the years. Others with a focus on measuring performance for individual fisheries found the check-lists less useful.

III.A.1. Stock Assessment Performance at the Agency Level

Participants suggested various forms of check-off lists to measure the overall performance of stock assessments within the NMFS (See Appendix I, Boggs and MacCall for specifics). Improvement in the overall scores over time would indicate general improvement in the way the agency conducts fishery stock assessments in support of fishery management. However, as pointed out by others (Appendix I, Wetherall) a check-list would do little measure performance for a specific fishery.

III.A.2. Specific Fishery Management Performance and the Role of Stock Assessment

More complicated methods may be called for to improve the fishery management of a particular fishery or to diagnose the performance of the stock assessment element within a particular fishery management scheme.

An important point is that a stock assessment itself is the culmination of years of research in most cases and that improvements will likely come from collecting data on new variables to improve the underlying science supporting the estimates. Also, as pointed out by MacCall the subtle but important distinction that better (more precise) stock estimates contribute to answering the question: " How sure are we that the stock is NOT overfished?" not "How sure are we that the stock is overfished?"

The "mind-set" of the principals involved regarding the two questions will also complicate the performance measure. Is NMFS ready to accept the more conservative approach (first question) and rank performances accordingly?

Two of the basic approaches proposed for measuring performance at the fishery level are a) peer-reviews of the scientific aspects of the fishery management system, and b) a comprehensive analyasis and development of regional stock assessment improvement plans (Appendix I, Alaska Center) for each NMFS Region.

IV. Recommendations

As a result of the foregoing discussion, we can make three recommendations regarding the performance measures of stock assessments.

1. NMFS must, at a very high level, discuss the meaning of performance measurement and specify who will be responsible for measuring performance of what and for what purpose. NMFS must explain what context(s) it is interested in pursuing and how performance data will be used. Will it be used internally for planning, programming, and budgeting, for example, or externally for forcing improvements in the Fishery Management Councils, informing Congress on needed changes and improvements, etc..

2. Re-write and move the stock assessment performance element to the Foundations section of the Strategic Plan, either to that for #1, Science or for #5, Agency management, infrastructure, and workforce. This will allow the agency to evaluate the very important activity of stock assessment across the agency without giving its precision in any one case undue weight in the evaluation of a particular fishery management scheme at the regional level.

3. Rethink the ways and means of evaluating performance of fishery management at the regional/fishery level without giving undue weight to the stock assessment part of the system. Specifying criteria, within context, for measurement of the system's performance or outcome is very important. Some who get to fish at high levels for one more year may think the system is a howling success while others who wish to have a fishery over the next 5 -10 years would consider the same scheme a failure.

Consider peer-reviews and plans for improvement of regional stock assessments when previous analysis (diagnosis) shows the fishery management system could be improved substantially with better stock assessments.

Appendix I - Comments of videoconference participants

Alec Mac Call (E-Mail 1)

While I wouldn't feel badly about getting rid of this performance element altogether, it seems that there may be more to gain than to lose in keeping it and highlighting it. Even in a worst case, what are they going to do? Cut our funding for stock assessments? Actually the worst case would be to look so good that they (NMFS, NOAA, Congress) feel that stock assessment already has enough support.

Chris Boggs' proposal is do-able, and captures the overview that we need. The check-box format should result in a very streamlined reporting requirement that should only take a few minutes of time to complete. I am not enthusiastic about Norris Jeffrey's' proposal for regional "Stock Assessment Improvement Plans" but won't go into the half-dozen or so reasons here.

Here is my list of proposed items for the checklist:

For each assessable unit:
1. Has a stock assessment ever been done? (no=0, 1=yes)
2. Has a stock assessment been done in the last five years? (no=0, 1=yes)
3. Are there quantitative estimates of the precision and bias? (no=0, 1=yes)
4. Has the stock assessment received a peer review in the last five years? (no=0, 1=yes)
5. Has biological productivity been estimated as a basis for management? (no=0, 1=yes)

Notes: Assessable unit refers to the finest division that management needs information on. In the case of salmon, this would be ESUs and/or individual river systems. Some species will be aggregated until management recognizes a need for individual treatment.

#1 gets at the fundamental problem, while #2 addresses the timeliness problem (e.g., on the west coast, Oregon's nearshore flatfish were surveyed 20 years ago--that earns one point because it has been done, but not the second point for timeliness). Five years is just a suggestion. It is difficult to improve a stock assessment unless #3 can be answered "yes." It is important to include both (im)precision and bias here, as a highly precise but unwittingly biased assessment could be very dangerous. With regard to #4, peer reviews need not be conducted every year, but credit should be given if one has been conducted recently. I include #5 because the wording of the performance element suggested it. Importantly, very few of our fisheries can earn a "yes" here, but again, credit should be given. SPR-based management does NOT earn a "yes" in #5.

It would be especially useful to use this scheme to compile a time series of national performance since perhaps 1980, soon after the MFCMA got underway. That would put our present performance in the long-term context it needs (is some amount of year-to-year variability

normal?). It also would show patterns of where we are making headway and where we are stalled. Overall scores should be going up over time, but how much is due to assessing new species vs. improving or reviewing those on old species? Of course, both are valid accomplishments that contribute to the goal of this element.

In the above scheme, an individual stock can receive up to 5 points, but few will earn above 3. Disaggregating stock complexes into individual assessments will earn more total points, which makes sense. It is not so much the total score, but the trend in total score that is important. Finally, I am serious about peer-reviewing the management systems. NMFS is in a position to promote the idea, and should do so.

Alec MacCall (E-mail -2)

No one has clarified how these performance measures will be applied. I have been assuming that they will be applied to NMFS as a whole. Most of the emails I am seeing seem to assume that they will be applied at the Center or even Division/Laboratory level, which would be a terrible mistake. The important principle here is that the more local the level of application, the more detail we are forced to consider in the performance measure--it is doomed to failure from the beginning because there is no common currency to work with. As long as it is at the national level, we can keep the measure remarkably simple and let the details average out, and it has a good chance of serving the purpose.

The principles I listed were more oriented toward the original "uncertainty" orientation of the performance element, but here they are:

1. The most important stock assessment is the first one. The (numerical) majority of our stocks have never been assessed. We have probably covered most of the larger and economically more important ones.

2. Frequency is at least as important as precision. The value of stock assessments declines with time, so a highly precise but infrequent assessment doesn't gain us very much in the long run.

3. Considerations of accuracy and bias are as important as precision. We are not served well by assessments that are very precise, but consistently wrong.

4. The original wording included uncertainty about biological potential. This requires time series of assessments. We also need to consider natural variability in biological potential; it isn't necessarily fixed over time.

I also made the philosophical point that the need for less uncertainty is not to answer the question "How sure are we that the stock is overfished?" but rather to answer "How sure are we that the

stock is NOT overfished?" This may sound trivial but it actually lies at the heart of most of our management failures. The first question contains no precaution, and assures that management response will be "too little, too late." It takes a resource collapse to convince some people (especially fishermen and industry representatives) that there is a problem. The second question embodies precaution as required under the new SFA, but most fishery councils are not ready for the conservative harvests that result. Notably, decreased uncertainty has a clear payoff when the second question is asked. It is more nearly neutral with respect to the first question.

I didn't say this in the conference, but I remain convinced that peer reviews are pretty worthless, and make things worse as often as they make things better. Their main virtue may be that they make some people feel better. Peer reviews are "in" these days, so I'll go along. Just remember that the North Atlantic cod assessments went through several world-class peer review panels, and collapsed anyway. Ironically, the main flaw in the cod assessments was a classical problem and should have been seen by the experts.

Larry Jacobson

My comments are brief. Rewrite the Performance Measure 1.2 so that it is more general and flexible. Something like: Improve stock assessments and stock assessment advice by improving precision and accuracy, developing new data sources, assessing new stocks, improving characterizations of uncertainty, increased external and internal review or other means.

Jerry Wetherall

I don't advocate a simplistic, check-list approach to scoring performance on stock assessment. Yes, you could construct a variety of short lists (Chris' 10 elements are good), and you could tabulate scores till the cow's come home. But where would it get you? To render a useful interpretation of the scores, you'd still have to provide the full context of the problem: resource characteristics, management setting, regulatory approaches, etc.

Who's job is it to keep score? If this is a necessary headquarters function, I suggest that a person there be responsible for getting out to annual science center program reviews, peer reviews, SSC meetings, and the like to get first-hand exposure to how the assessments are done, what goes into them, what the constraints are, etc. Or monitor reports from such meetings. Such a person then ought to be able to report with some assurance on stock assessment performance in the agency.

Pierre Kleiber

A few comments regarding the check list idea: I suppose a check list might be OK for indicating some of the common things that ought to be done in conducting a stock assessment, but any such list needs to have a large box for extensive comments that set the context of the stock assessment by outlining the cogent management questions i.e. is it a question of abundance? or whether overfished? or allocation? or degree of fishery interaction?; and furthermore answering such questions as: is the stock highly migratory?, straddling?, subject to multiple fisheries?, part of a multi-spp complex?, anadromous?, etc. etc. All these questions influence what should be the appropriate steps to take and thus the appropriate headings in a check list. If I'm dealing with tunas, do I get marked down because I haven't checked an item for conducting stream counts?

To repeat what I said "on the air", I think any fair and appropriate assessment of our stock assessments will necessarily be a summarization of a bunch of anecdotal information about each of the stock assessments. It's perhaps ironic that a quantitative person would resist quantifying, but I see a danger in the possibility of misleading quantitative summaries or analyses. A check list could be vulnerable to someone simply counting the check marks and doing highly inappropriate statistical analyses. Maybe you saw a draft last year of an agency-wide report on the situation of NMFS about. bycatch. In it was a giant spp. by spp. table similar to what I imagine a stock assessment check list would look like. Also in that report was an analysis of that table in which an obviously statistically naive person must have run amok with the computational power of a spreadsheet and produced absolute nonsense. Such stuff may only be a waste of time if assessments of stock assessments are simply going to be filed away and forgotten, but if they are going to influence allocation of resources to and within the agency, then it is of great concern that they be meaningful.

Chris Boggs

I suggested a scoring system for providing an overview of the quality of stock assessments. I would also be happy with the elimination of this performance measure, although pressure to define performance measures will probably increase (rightly so). National; performance measures need not be the best scientific evaluation of our work. Their primary purpose is to provide some metric to our constituency that will show concrete progress and highlight strong and weak areas. The field programs can be trusted to also take a highly professional and scientific approach to improving the quality of stock assessments. The detailed reporting of programs to improve stock assessments on a regional basis are already a part of annual program reviews, peer reviews, and reviews by the SSCs of the fishery management councils. This sort of detail may not be needed for a national overview.

One objection to the score card approach was that it wouldn't incorporate the breadth of research that must be accomplished to improve the quality of assessments. Perhaps this could be overcome by including points for the use of certain types of information that are often ignored or guessed at, such as stock structure, age structure, mortality rates, and environmental variation in carrying capacity, catchability, and availability.

Score Card:
1) has a stock assessment been conducted within the last 5 years? (yes = points)
2) is a stock assessment conducted annually? (yes = points)
3) does the stock assessment provide a quantitative measure of uncertainty (yes = points)
4) does the stock assessment include a formal risk assessment (yes = points)
5) are the core statistics adequate (yes = points) or merely "best available" (no points)
6) is there any validation of core statistics with surveys, observers, or other means (yes = points)
7) are the boundaries of the stock known (yes = points) 8) is an age-structured model used (yes = points) 9) is independent information on mortality rates used (yes = points)
10) are environmental variables considered in the assessment (yes = points)

Score = x. For details of the assessment process contact Xxxxxx Xxxxx, Xxxxx Laboratory NMFS

Comments from the Alaska Science Center Hollowed, Ianelli, Thompson, Terry and Jeffrey

A copy of J. Terry's notes from the video conference were faxed to you earlier today. They may be of some help in putting together a summary.

We appreciate the opportunity to participate and offer the following for your consideration....

1. We are pleased to see that the NMFS Strategic Plan is a "living" document and can be altered as needed;

2. Involving stock assessment scientists ("the doers") in discussing the nature of their work and how it can and should be measured is a critical and positive step in developing meaningful ways to measure performance. The "brainstorming" technique using videoconferencing was effective given the time and work-load constraints of the participants. Similar face-to-face interactions involving people who actually do the work related to the other NMFS performance measures in both field and headquarters should be considered.

3. Wording for NMFS Performance Measure "1.2 Reduce the level of uncertainty....." should be changed to reflect a more generic and comprehensive measure of improvement in NMFS stock assessments. Something on the order of "Improve NMFS assessments of stocks."

4. We recommend as a first step in achieving improvement in stock assessments, the development of a series of regional stock assessment improvement plans. Format and content could be standardized with appropriate regional flexibility. First year's objective and

performance measure would be the production of the improvement plans. Performance in subsequent years could be measured by assessing progress towards achieving the objectives of the individual improvement plans.

Content of the improvement plans might include:

1. Current status of assessment for all managed species. Has the species been assessed and at what frequency? We might need to develop some measure/statement of adequacy of each of the current assessments.

2. Identify sources of uncertainty related to the assessments and how to measure the uncertainty.

3. Peer review of assessments - frequency, processes for internal council related and external reviews, results of previous peer reviews.

4. Risk assessment and reduction

5. Previous history of assessment relative to management process. Acceptance, or rejection of scientific advice?

6. Data gaps

7. Costs associated with maintenance of current assessment and costs for improvements

Thanks for your efforts!

Appendix II
Stock Assessments Performed by the Southwest Fisheries Science Center

SWR SF Performance Elements

SPECIES or GROUP		LAST	NEXT	INT(YR)	CV%	
Pacific swordfish		1988	1998	n/a	n/a	
yellowfin tuna	CWP	1997	1998	1	unk*	
skipjack tuna	CWP	1997	1998	1	unk*	
bigeye tuna	CWP	1997	1998	1	unk*	
albacore	NP	1997	1998	1	**	
marlin spp.		1988	n/a	n/a	n/a	
mahimahi						
wahoo						
pelagic sharks						
other Pacific highly migratory spp.		See attached table of details				
NWHI squirrel fish (ehu)		1996			CI	
NWHI longtail snapper (onaga)		1996			CI	
pink snapper (opakapaka)		1996			CI	
other snappers						
giant trevally (white ulua)						
other jacks						
NWHI seabass						
other groupers						
redgill emperor						
other bottomfish and seamount groundfish		See attached table of details				
spiny lobster		1997	1998	1	n/a	
slipper lobster		1997	1998	1	n/a	
other crustaceans						
pink coral						
other precious corals						
northern anchovy		1997	1998	1	n/a	
other coastal pelagics:						
	sardine	1997	1998		n/a	***
	jack mackerel		n/a			
	Pacific mackerel	1997	1998	1	n/a	***
	squid	n/a	n/a			
fall run Klamath river chinook						+
chinook, central valley, CA						++
other California salmon						+++
bocaccio		1996	1999	3	. . 30	
chilipepper rockfish		1993	1998	3	. . 30	
near shore rockfish in central and						

southern California	Responsibility of state				
other California groundfish					
widow rockfish	1997	2000	3	. .	30
darkblotched rockfish	1993	n/p	n/p	.	30
shortbelly rockfish	1993	n/p	n/p	.	50
splitnosed rockfish	1994	n/p	n/p	.	>20
bank rockfish	1994	n/p	n/p	.	large
"minor" offshore rockfishes	1990	n/p	n/p	.	large

* Formal assessments last done 1990 though assessments are updated each year; assessment technology not at stage to estimate precision.

** CIs calculated for Albacore MSY but both thought not to be reliable; Specific Biological Indicators (SBIs) are being investigated as best way of monitoring albacore.

*** With State of California

+ Limited involvement---State, Klamath River Technical Team, PFMC Salmon Technical Team have primary responsibility.

++ Limited involvement---State, PFMC Salmon Technical Team have primary responsibility.

+++ Limited involvement---SWR has primary responsibility for species listed under the ESA.

Appendix II Attachment A.

Details of Pacific Highly Migratory Species Stock Assessments

Population (Putative)	Prior or Next "Assessment" [data through]	Type of Analysis, and Result(s) [+/- 95% CI]	By
Pacific Swordfish	1988 [1980]	MSY 18,000-43,000 mt [no CI or CV]	NMFS
E. Pac. Swordfish	1994 [1987]	AMSY 4,000-8,400 mt [no CI or CV]	IATTC
Pacific Swordfish	Next: 1998	AMSY ?	ISC/NMFS
Blue Marlin	1988 [1980]	MSY 19,000-24,000 mt [no CI or CV]	NMFS
Blue Marlin	1988 [1985]	MSY no fit (unknown)	FSFRL (Japan)
Blue Marlin	Next: Not Scheduled		MLHLCWP ?
Striped Marlin	1988 [1980]	MSY no fit (unknown)	NMFS
N. Pac. Stripe. Marl.	1988 [1985]	MSY no fit (unknown)	FSFRL (Japan)
S. Pac. Stripe. Marl.	1988[1985]	MSY 5,700-9,100 mt [no CI or CV]	FSFRL (Japan)

C. Boggs
SWFSC
Honolulu

Appendix II Attachment B.

Details of Hawiian Bottomfish Stock Assessments

Management Zone	Species	SPR (%)	90.25% Lower Limit	90.25% Upper Limit
Main Hawaiian Islands				
	Hapuupuu	21	15	28
	Onaga	5	3	8
	Ehu	8	5	17
	Opakapaka	28	21	40
	Uku	45	25	85
Mau Zone				
	Hapuupuu	56	32	101
	Onaga	59	33	93
	Ehu	51	33	82
	Opakapaka	51	32	85
	Uku	51	32	83
Hoomalu				
	Hapuupuu	78	58	101
	Onaga	67	47	112
	Ehu	77	60	97
	Opakapaka	77	60	97
	Uku	78	60	98
Hancock Seamount				
	Pelagic Armorhead	1		

The SPR value presented for the pelagic armorhead at Hancock Seamount is the 1995 proxy value based on the value calculated using Japanese data from Colohan Seamount in 1995. The remaining spawning potential ratios (SPRs) are 1996 estimates calculated using current versus virgin values for catch per unit effort and the percent of mature individuals in the catch. Confidence limits are based on the best and worst case scenarios for the non-parametric bootstraped 95% confidence limits for cpue and percent mature values.